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Division of State & Private Forestry
Missoula, Montana

GUIDELINES FOR LINE-PLOT SAMPLING

A

MOUNTAIN PINE BEETLE INFESTATION

ON THE

CLEARWATER NATIONAL FOREST

FILE COPY
FOREST INSECT
RESEARCH
MISSOULA, MONTANA

June 23, 1961

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Introduction

A normal forest contains many insects both beneficial and harmful. Periodically, conditions become very favorable which produce rapid insect population buildups. The resultant abnormal insect numbers is called an epidemic.

In the Northern Region many dead trees are mute evidence that past insect infestations were often epidemic. These depredations have been responsible for billions of board feet of dead timber. For example, a mountain pine beetle epidemic in North Idaho from 1911 through 1913 caused a loss of 1,400,000,000 board feet of merchantable white pine.

One of the first large insect control projects was during 1926 through 1928 for the mountain pine beetle epidemic within the Big Hole Basin of Montana. Although various control methods were used, the mountain pine beetle continued to increase in numbers to kill over 2 billion board feet of lodgepole, white bark pine, and ponderosa pine before the infestation subsided. Other bark beetle epidemics have occurred in lodgepole pine, white pine, Douglas-fir and Engelmann spruce stands. The actual amount of loss from forest insects is hard to measure. Forest entomologists estimate that the annual loss from tree-killing bark beetles is about 5,000,000,000 board feet in the western part of the United States.

Objectives

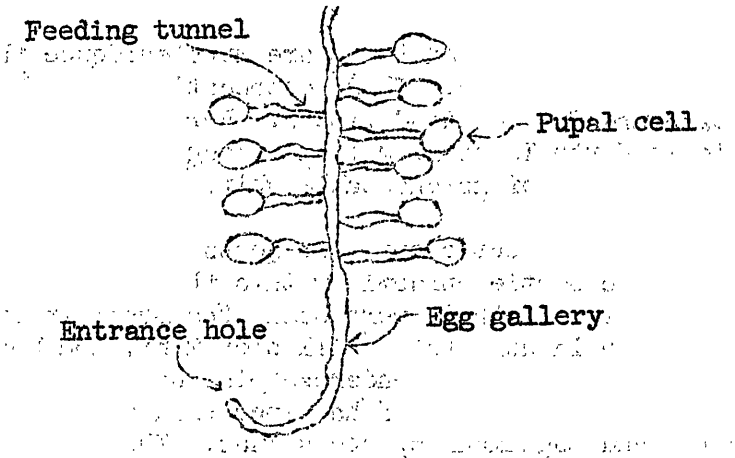
The importance of surveys cannot be overemphasized. They are the foundation for efficient planning of every phase of insect control. The results of these surveys are the basis for expenditures of hundreds of thousands of dollars and the efforts of thousands of man-days.

Survey data must be collected, summarized, and evaluated correctly. It is the basic information for direct control projects or in planning roads, trap tree felling and sales programing for control by logging. The survey information must be adequate to determine the spread or decline of the infestation and the presence or absence of any natural control. The high quality work expected in making surveys is as essential a part of the control program as is the actual removal of infested trees from the forest.

The objective of this survey is to determine the intensity of attack and general location or boundary of the infestation by obtaining an estimate of the number of trees attacked within a reasonable degree of error ($\pm$ 25%), and the location and distribution of infested trees.

Identification of the Attacked Trees

The mountain pine beetle is a typical bark beetle; cylindrical with hard chitinized wing covers, always black in color, and 1/8-to 1/5-inch long. It constructs a straight egg gallery in the inner bark which is parallel to the grain of the wood. The gallery ranges in length from 12 to 36 inches and has a characteristic J-or L-shaped hook at the lower end. The larva excavates a short feeding tunnel at right angles to the egg gallery. When full grown, the larva constructs a small pupal cell at the end of this feeding tunnel, where it transforms into a new adult after about 2 weeks in a resting stage (pupal stage).



When the first attacking bark beetles bore through the outer bark and penetrate the inner bark, resin starts to flow through the entrance hole to seal the wound. As the beetles continue their work of boring and pushing out the dust, the pitch becomes mixed with the dust and forms a gummy mass. This mixture accumulates around the entrance hole in a tubelike formation. In some instances the pitch flow is heavy and the pitch tubes are large. However, pitch tubes and boring dust are the usual indicators of a bark beetle infestation.

Vigorous growing trees often produce pitch flows which either force the beetle out or trap it in the pitch. This type of an attack is called a "pitch out." In most cases, pitch outs indicate a tree is free of bark beetles. If beetles are not seen in the pitch tubes, the egg gallery area should be examined by removing a small section of bark with a hand ax. A pitch-lined egg gallery or the absence of an egg gallery indicate a pitch out. Frequently the first few beetles making the initial attacks are overcome by pitch flow. These are "pitched out" attacks. Succeeding beetles may then overcome the tree. In some instances, however, no further attacks are made. These trees will live.

Host Type

In timber stands where the host type is mixed with other species, standards must be set to indicate the dividing point between host type and non-host type. Thus, the rule to use is that when 10 percent of the mature trees in a stand are white pine it will be recorded as host type. When there is less than one white pine tree in 10 trees, the stand will be classified as non-host type and recorded as being of the tree type that predominates. When there is doubt as to type, one should count the nearest 50 trees and note the number of host type trees to determine the percentage.

Line-Plot Method

This method establishes circular plots uniformly over the area to be sampled. All mature western white pine trees on each plot are carefully examined for bark beetle attacks. There is no need to cut into trees unless external evidence of attack is observed.

1. Line location

Using the field map on which plot lines have been sketched, starting points are located in reference to section lines, road or trail junctions, or other physical features. Each line runner selects his daily line by a chance drawing of his assignment slip (figure 1). These slips have been filled in by the Chief of Party and show starting point, bearing of line, and length of line in chains. Starting points should be located with a practical degree of accuracy. Where section lines cannot be located after about an hours search, it is best to estimate the line location and tie into a definite physical feature. Starting points should be marked with paper, shipping tags which are hung so as to be plainly visible from trail or road. The tag will give the plot line number, and direction and compass bearing of the line. Compass lines will be 20 chains apart.

2. Plots

One-tenth acre circular plots will be placed at 2 chain intervals along the compass line. Thus, there will be 40 plots on each mile of line giving a 2.5 percent coverage of a section. Care must be used in estimating plot area on steep slopes.

3. Mechanics of the job

a. Pacing.

Distances are measured by pacing. A pace is normally a double step and most men will pace a chain (66 feet) in from 11 to 12½ paces when walking at a natural gait. Care must be taken not to lengthen their stride. In climbing a hill one must shorten his steps, thus, instead of the usual two steps per pace, one counts three steps per pace or on very steep hills the count is four steps.

Old-timer cruisers often used a stick in pacing. This stick was cut just long enough to reach the end of the cruiser's pace when the arm was extended comfortably. Trainees can easily see why they must take more than two steps to their level ground pace, if stick pacing is practiced for a few days. Good pacing cannot be learned in a day or two, thus, each surveyor will check his pacing at every opportunity.

b. Compass line.

The compass line on which the plots are established will be run with a box compass.

Although this compass is less accurate than a staff compass, one man can run a fairly accurate line by watching his shadow without taking a head site. With practice such a line can be run within about 5 percent of accuracy - 4 chains error per mile. In using a box compass a surveyor can check doubtful peripheral trees when going into or leaving a plot. An accurate count of the attacked trees on the sampled acreage is more important than an accurate compass line.

The compass ring on this compass is divided into four quadrants of 90 degrees each, thus, we always use bearing angles in insect survey work. The E and W cardinal points are reversed from their true positions on the compass dial, thus, the north end of the needle automatically gives the directional bearing of the line of sight. One must always read the north end of the needle which is the end opposite the balance wire. When sighting ahead keep the compass level by keeping both ends of the needle even with the compass ring.

The compass is a delicate instrument, thus, must be used with care. When not in use the cover must be kept closed so as to prevent the needle from riding on the pivot. To prevent dropping the compass keep the cord looped around one's neck at all times. Wax pressed around the bezel ring prevents moisture from getting into the compass during wet weather.

c. String lines.

The plot taker will mark his compass line by using a string line.

The greatest use of the string line is to check the strips periodically for errors. However, it aids materially on re-examination of doubtful areas of infestation. It is also a safety device and may be used in finding a lost or injured person.

Each plot taker will fasten a two-pound cone (7 miles) of light No. 40 cotton thread to his belt by means of a cone plug and swivel snap. The string is tied to some object at the starting point and it unwinds as the plot data is collected.

c. Plot measurement.

A circular plot is difficult to lay out precisely on sloping ground. The shape of a plot on a slope is actually oval with the long axis extending up and down the hill. When pacing from plot center to plot center, one can establish the location of borderline trees. On level ground the plot diameter is 37.2 feet or .56 of a chain.

Recording Line-Plot Data

Reference is made to figure 2 which shows outgoing and incoming sample strip sheets. Data regarding the line number and starting point are copied from the line assignment slip (figure 1) to the heading of these forms. Under the "Bearing and Plot" column is recorded the direction and plot number. In the second column the green trees will be recorded. Under the 0-2" column is recorded the number of attacked trees with egg galleries under 2" in length and column 4 for number of trees with 2+" egg galleries. Pitch outs will be recorded in column 5. The remarks column should be used to record changes in type and other pertinent data.

1. Number of infested trees

The infested trees will be classified and recorded in three categories:

a. Recent attacks having egg galleries from 0 to 2 inches in length;

b. Attacks having egg galleries over 2 inches in length;

c. Attacks that are pitch outs (P.O.A.).

2. Trees per acre

After the total acreage of the survey area is determined, a tree per acre figure will be computed.

3. Boundaries of infested areas

Sufficient data will be taken and recorded to show breaks in host type. It is always desirable to limit the acreage of the infested stand. This term "host type" designates the timber type harboring the mountain pine beetle. After the plots are run, the number of infested trees are plotted on 2 inch-to-the-mile scale map. Boundary lines can then be drawn around the infestation but a least a 1/2-mile buffer strip will be added to the area of known infestation.

Checking Plots

About 10 percent of the plots should be checked. These strips are checked by the Chief of Party or occasionally by someone designated "checker for the day." The line is picked by chance from box containing the numbers of recently run strips. The checker then reruns the line of plots, records the infested trees, and notes any difference between his pacing and compass line direction.

Safety

The Chief of Party will be furnished a Forest Service Safety Manual for camp use. Weekly safety training sessions will point out the hazards of the job and the means to avoid accidents. The following hazards exist and are listed in order of their importance:

1. Transportation

All drivers must have current Forest Service driving license. Those who drive trucks and are hauling men to and from work must realize that the safety of the crew is his responsibility while he is driving. The driver has no right to jeopardize anyone riding with him.

2. Falling

There are hazards in the ordinary process of just walking in the woods, but if one becomes tired they are more prone to falls than a rested man. Walk with a full stride, it is less tiring.

Cuffless trousers are recommended to avoid catching the cuffs on snags or dead branches. Chalked shoes are recommended to give more secure footing. Walking on windfalls should be avoided, as loose bark often causes falls.

3. Getting lost

Always believe your compass. It is right unless it has water in it. Local attraction is largely a myth and where present would hardly be noticeable with a box compass. In the event that you do get lost, GO DOWN HILL. That is the infallible rule. If you go down hill you will come to a draw or stream. Go down the draw; you will come to a trail or road or larger stream or to a lake shore. Go around the lake and continue down. You will always come out to some point where you can be picked up.

4. Firearms

Firearms will not be permitted to be carried or used on a survey crew. Any firearms brought into camp by survey personnel should be sent home.

Strip No. 10 Date 8-21-61

Forest Clearwater

Starting Point Sec. Line between Sec. 9 & 10 T27N R25W on Upper Lost Prairie Road

Bearing	Chains
North	30
East (Deadhead)	20
South	130
West (Deadhead)	20
North	100

Car

/s/ J. Bushfield
(Signature)

Figure 1 --- Strip Assignment

Page 1

Strip No. 10 Date 8/21/61

Forest Clearwater Signature /s/ J. Bushfield

Starting point 10 chains E of Sec. line between Sec. 22 and 23, T40N, R8E, on Quartz Creek trail (Plots 2 chains apart)

Bearing & plot No.	0"-2"	2"+	POA	Dead mature	Remarks
North					
1		0			Going up ridge
2		0			
3		0			
4		0			Host ends 33 chains
East					
					Deadhead 20 chains
South					
1		-			
2		-			Host begins 19 chains
3		0			
4		0			
5		0		1	Level country
6		0			Level country
7		1			Windfall - Road 61 ch.
8		2		1	Going up ridge
9		1			Going up ridge
10		0			Going up ridge
11		0			WWP thinning out
12		0/-			Host ends 125 chains

Page 2

Strip No. 10 Date 8/21/61

Forest Clearwater Signature /s/ J. Bushfield

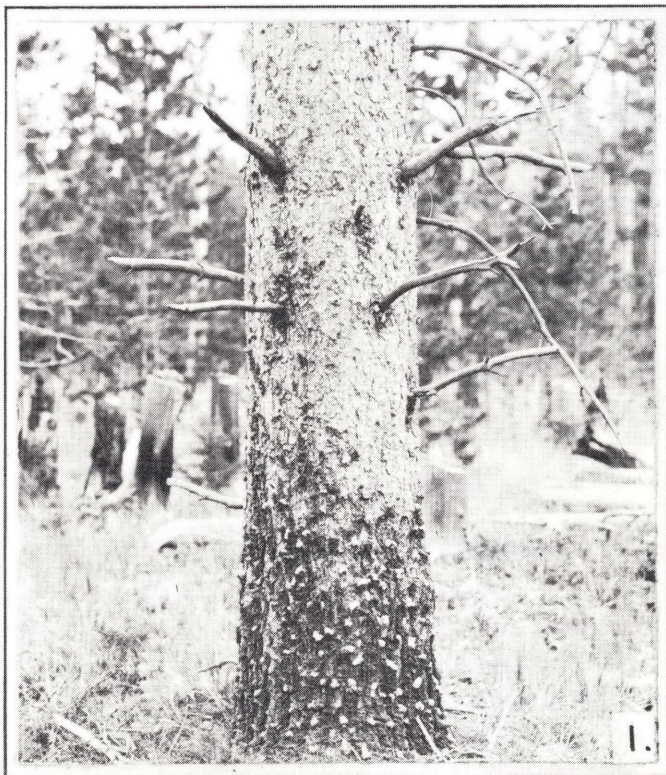
Starting point 10 chains E of Sec. line between Sec. 22 and 23, T40N, R8E on Quartz Creek trail

Bearing & plot No.	0"-2"	2"+	POA	Dead mature	Remarks
West					
					Deadhead 20 chains - along ridge
North					
5		-			Going down ridge
6		-			Host begins 18 chains
7		0			
8		0			
9		0			
10		0			Heavy western white pine
11		0			Meadow at 68 chains
12		-			Meadow
13		-			Meadow
14		-			Meadow - Road
Etc.					

Figure 2 --- Strip Sheets

MOUNTAIN PINE BEETLE

Dendroctonus monticolae Hopk.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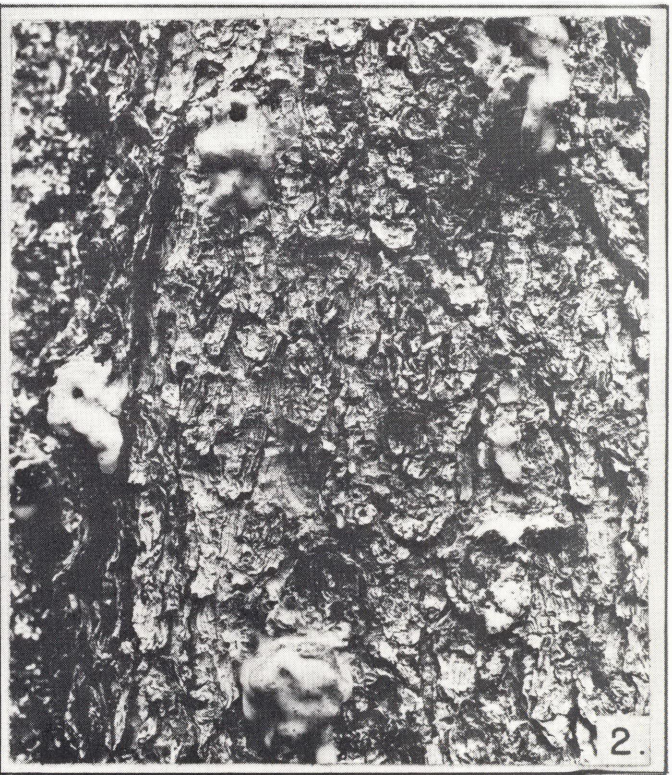
2.

3.

4.

1. Pitch tubes on heavily attacked lodgepole pine.
2. Close-up of pitch tubes on bark.
3. Egg galleries and larval mines with young larvae.
4. Egg galleries, larval mines, pupal cells, pupae, and adults.

MOUNTAIN PINE BEETLE

Dendroctonus monticolae

PRINCIPAL TREES ATTACKED

LODGEPOLE PINE, WESTERN WHITE PINE, PONDEROSA PINE.

EXTERNAL CHARACTERISTICS

(WHITE PINE BETWEEN SEPT. 1 & JAN. 1).

AGE OF ATTACK	CURRENT YEAR	PREVIOUS YEAR	THREE YEARS OLD
FOLIAGE COLOR	GREEN & FADING (SORREL)	RED	RED
NEEDLE COMPLEMENT	90 % TO 100 %	50 % TO 80 %	10 % OR LESS
BORING DUST	FRESH & RED IN SOFT PITCH TUBES.	"SALT & PEPPER" APPEARANCE IN WEATHERED PITCH TUBES.	OLD DUST.
BROOD STATUS (UNDER BARK)	ALL STAGES OF BROOD MAY BE PRESENT.	NO BROOD. SECONDARY BEETLES MAY BE PRESENT.	NO BROOD.

INFESTATIONS FROM BASE OF TREE ON MOST OF BOLE DURING EPIDEMICS.

CHARACTERISTIC GALLERY PATTERN

EGG GALLERIES

1. PACKED WITH BORING DUST.
2. ONLY AS WIDE AS BEETLES.
3. LONG (12 TO 36 INCHES). PARALLELS GRAIN OF WOOD.

LARVAL MINES

1. SHORT & AT RIGHT ANGLES TO EGG GALLERY.
2. TERMINATED BY SHALLOW PITS OR PUPAL CELLS (ALWAYS BETWEEN BARK & WOOD).

FLIGHT PERIODS

JUNE TO SEPTEMBER.

LIFE CYCLE

NORMALLY ONE GENERATION A YEAR, BUT THIS BEETLE OVERWINTERS IN ALL STAGES OF DEVELOPMENT EXCEPT PUPAE. THEREFORE, OVERLAPPING BROODS ARE COMMON.

CONTROL-

DIRECT

1. **LOGGING - FOR CONTROL**
2. **CHEMICAL TREATMENT IN SPRING OR FALL**
3. **FELL And BURN-OR PEEL**

INDIRECT

Predators

1. **WOODPECKERS**
2. **FLY LARVAE**
3. **CLERID BEETLE LARVAE**

Parasites

WASP-LIKE INSECTS (Coeloides sp.)

Climate

COLD WEATHER *After active period. Before "cold hardiness" or in late Spring*

REFERENCES-

Insect Enemies of Western Forests, Revised July 1952 - U.S.D.A. - Misc. Pub. No. 273

The Mountain Pine Beetle, an Important Enemy of Western Pines, March 1943- U.S.D.A. Circular No. 664

Agriculture—Missoula, Mon